General Application Name: Planning

Product / Service / Function Name: Development & Maintenance of Comprehensive Plan

P/S/F Description:

Comprehensive plans are developed in order to help guide community decision-makers in planning for and responding to future growth and development in a municipality. It serves as a guide to the public and private sectors by providing a predictable plan for the growth of the community as well as cites the principles that will be employed in order to balance competing interests. The process of developing a comprehensive plan is extensive. It involves analyzing the existing assets in the community, such as transportation, land use, zoning, and environment, as well as identifying demographic and economic trends. Once this initial analysis is complete, then future goals must be defined and a vision for the community agreed upon. This leads to changes in public policies. Development of a comprehensive plan also involves input from the public. Often, public meetings and hearings are held to give citizens a chance to be heard regarding the overall plan. These opinions are often included in the final plan.

A final, published comprehensive plan often includes several maps showing the distribution of the municipality's current and planned assets as identified during the process. GIS is often the tool of choice to create these maps for comprehensive plans. Aside from creating quality reference maps, GIS data can be utilized to aid in decision-making throughout the entire process of creating a comprehensive plan.

Product / Service / Function

1. Spatial Data:

   Minimum Requirements:

General Description	Data Layer
Land Base/Planimetrics	Digital Raster Graphics (topographic maps)
Natural Features	Parks
	Wetlands
	Streams/Rivers
	Geology
	Floodplains
	Vegetation
	Contours (elevations)
	Watersheds
	Soils
Transportation	Street Centerlines
	Major Highways
Socio-Political Data	Municipal Boundaries
	Historic/Archaeological Features
	Zoning
	Current Land Use
	Future Land Use

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Optional Requirements

General Description	Data Layer
Land Base / Planimetrics	Building Footprints
	Parcels
Natural Features	Agricultural Security Areas and Easements
Utilities	Storage Tanks
	Treatment Plants
	Water lines
	Sewer lines
	Storm water
	Gas
	Electric
	Easements
Transportation	Street Double lines (Right of Way)
	Edge of Pavement
	Public Transit Routes
	Railroads
	Airports
	Bridges
	Parking lots
	Easements
Socio-Political Data	Zip Code Boundaries
	Census Tracts
	Municipal Boundaries
	Census Block Groups
	Convenience Store & Retail Centers
	Legislative Districts
	Social Service Locations
	Prisons
	Neighborhoods & Subdivisions
	Special Overlay Districts
	Demographics
	Business Districts
	Industrial Parks
Community Facilities	Athletic Fields
	Cemeteries
	Golf Courses
	Fire Stations
	Schools
	Hospitals
	Police Stations
	Libraries
Industrial	Mines
	Quarries
	Power Lines
	Tower Locations

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2. Attribute Data:

Minimum Requirements

General Description	Field Name
Natural Features	*See Soils, Wetlands, and EIA topics*
Land Use Data	*See Land Use topic*
Zoning Data	*See Zoning topic*
Transportation	*See Transportation topic*
Historic /Archeological	*See Historic/Cultural Resources topic*

Optional Enhancements

General Description	Field Name
Buildings	Building Name
	Building Height
	Owner Name
Parcels	*See Parcel Inventory topic*
Demographic Data	*See Demographics topic*
Utilities	*See Water/Sewer, Pipe Inventory, Storm Water topics*
Transportation	*See Transportation topic*

3. Data Acquisition Options

Data sources required for the comprehensive plan development process can be obtained from numerous sources. Much of the environmental and demographic types of data can be obtained from the Federal government's spatial data clearinghouse <http://www.fgdc.gov>. From this gateway, data such as USGS topographic maps, floodplains, geology, and demographic statistics can be accessed.

Local data such as utilities, buildings, land use, zoning, streets, etc. are typically maintained at the county or city level. Street centerline data layers of varying qualities can be obtained from a number of vendors. The market is relatively competitive, and prices will vary with quality of the data. Relevant vendors that provide this kind of spatial data on a regional and national scale include: NAVTECH <www.navtech.com>, GDT <www.geographic.com>, and TeleAtlas <www.teleatlas.com>.

Regardless of the source of the data, each data layer used to build the comprehensive plan development application should be consistent with, or be modified to match, the projection of the Virginia Base Mapping Project (VBMP) orthophotography. Orthophotography can also be used to create new data as many features can be seen or interpreted (such as land use or building footprints). Orthophotos are also used extensively to create maps for comprehensive plans.

4. Data Conflation Options

Data conflation is a process by which two digital data layers, usually of the same area at different points in time, or two different data layers of the same area, are geographically "corrected" through geometrical and rotational transformations so that the different layers can be overlaid on

one another. Also called "rubber-sheeting," this process allows a technician to adjust the coordinates of all features on a data layer to provide a more accurate match between known locations and a few data points within the base data set. A good base layer to use for data conflation is the VBMP orthophotos since many features can be seen or interpreted. The need and processes for conflation varies between sets of data, users, and feature types. Any dataset that is updated independently by different departments can be consolidated through conflation. Within most local governments, individual departments are responsible for maintaining specific datasets within their expertise; therefore, conflation is not often necessary. Often, reprojecting the data into a different coordinate system will take care of the misalignment of different data sets. Most industry-standard GIS software has the ability to perform data conflation.

Data provided by the Federal government tends to have a standard projection and coordinate system. However, it may not match the projection/coordinate system of the VBMP orthophotography. Therefore, the collected data must be reprojected so that all features (e.g. land use, zoning, and parcels) are in the same coordinate space.

5. GUI / Programming Options:

There a few options for developers of a GIS-based comprehensive plan development application. Two avenues within this development track are:

- Standard GIS desktop software that can be customized to the user's needs
- Hiring a consultant to develop a custom system from scratch.

Using a standard GIS software package often requires a significant amount of training and customization. Whereas the initial cost may be lower, the time invested in learning these solutions may generally increase the overall expense of implementation. However, standard GIS software packages deliver more robust data integration, analysis, and cartographic capabilities than do other specialized commercial applications. They have a greater user support infrastructure that allows users to overcome problems quickly. Options for using an existing, industry-standard GIS software application that can be customized for comprehensive plan development include those listed in the following table:

Standard GIS Software Vendors:

Vendor	Software	Web Address
ESRI	ArcView 3.x	www.esri.com
ESRI	ArcGIS 8.x	www.esri.com
MapInfo	Professional 7.0	www.mapinfo.com
Intergraph	GeoMedia 5.0	www.intergraph.com/gis
Autodesk	Map 5.0	www.autodesk.com

The second option for developing and implementing a GIS-based comprehensive plan development application is to contract with a consultant. This option makes certain that a product will fulfill a jurisdiction's requirements. A consultant will be able to develop an application that works with the wide range of hardware and software that are currently in use within local governments within Virginia. Also, training and follow-up user support is often provided at a much more substantial level than with other options.

While GIS can be used to create the maps delineating current and future land use, zoning, transportation, etc. for the final comprehensive plan, it can also be used as a decision-making tool during the development of the plan. A GIS can help take some of the guesswork out of planning decisions and give local officials a tool based on science and community opinion. For example, a GIS application can:

- Display the probable future (based on existing land use, zoning and regulatory conditions)
- Analyze multiple alternative future land use scenarios (based on adjustments to land use policy and zoning regulations)
- Create Annual Average Daily Volume transportation maps
- Maintain the inventory of assets collected at the beginning of the planning process
- Use the future land use GIS data layer to determine community assessment impacts including approximate anticipated costs for schools, roads and emergency services.

6. Internet Functionality and Options:

The Internet has proven itself as a viable solution for the public dissemination of GIS data. As more local and state government agencies are implementing Web-based solutions, they are finding that the Internet does require them to change the nature of an application or its usefulness. Using the Internet, software can be easily updated and users gain greater accessibility to the applications and information they need for their specific tasks through simple, user-friendly interfaces.

While desktop applications are mainly for staff and "power users," an application can be deployed on the Web to allow greater access to this information for the community. Many municipalities offer interactive maps from their comprehensive plan online. The public can use these maps a reference tool. GIS software vendors have products that can be customized in-house or by a consultant to provide Web GIS applications on the Internet, over an intranet or via wireless network. The table below shows GIS vendors and their Internet mapping solutions.

GIS Internet Solutions

Vendor	Internet Software	Web Address
ESRI	ArcIMS	http://www.esri.com/software/arcims
MapInfo	MapXtreme, MapX	http://www.mapinfo.com
Intergraph	GeoMedia WebMap	http://www.intergraph.com/gis/gmwm
Autodesk	MapGuide	http://www.autodesk.com

7. Technical Requirements:

Minimum Technical Requirements
At its most basic level, a system for comprehensive plan development can be used on a single, stand-alone workstation. This workstation would have a hard drive that stores all of the spatial data layers, as well as a database containing a copy of all of the tabular records. A typical workstation running off-the-shelf software should have the following minimum specifications:

Processor: Pentium 3, 450 MHz
RAM: 128MB SDRAM at 133MHz
Hard Disk: 20GB (min.)

Monitor 1:	19"
Floppy Drive:	3.5”
CD-ROM:	12x/8x/32x CD drive
Modem:	56K
OS:	Windows 2000/NT/XP
Office:	Windows 2000 Professional
Printer:	8x11 office-grade color printer

Optional Technical Requirements:
A more complex analysis and mapping system may require multiple components, including servers, desktop workstations, and/or handheld devices. For either a client-server or a Web-based application, the system should rely on a fairly robust server computer and high-end workstations. Example specifications of the necessary equipment are listed below:

Server

Processor:	Min. 2x Processors, 1.7 GHz, 512K cache
RAM:	Min. 2x 512MB RIMMS
Hard Disk:	Min. 2x 80GB +RAID
Monitor 1:	19"
Floppy Drive:	3.5”
CD-ROM:	12x/8x/32x CD drive
Modem:	56K
Network Card:	10/100 mbps

Workstation

Processor:	Pentium 4, 1.5 GHz
RAM:	512MB SDRAM at 133MHz
Hard Disk:	20GB (min.)
Monitor 1:	19”
Monitor 2:	17”
Floppy Drive:	3.5”
CD-ROM:	12x/8x/32x CD-RW drive
Modem:	56K
Network Card:	10/100 mbps
OS:	Windows 2000/NT/XP
Office:	Windows 2000 Professional

Other Components

Printer:	8x11 office-grade color printer and 8x11 production b/w printer
Plotter:	HP DesignJet 1055CM
Tape Backup:	Tape Library Server
UPS:	APC 1400 (or other similar)
Scanner:	11x17
Handheld:	Compaq IPAQ
Network:	T1

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8. Administrative/Management Requirements

At the beginning of the project, the assigned project manager should consider completing some, if not all of the following tasks that relate to the administrative requirements of the project:

- Determine, with or without the assistance of a consultant hired to develop the system, the preliminary vision and goals of the project.
- Determine the stakeholders of the project (e.g. Board of Supervisors, City Council, planning department, transportation department, local environmental agencies, school board, engineering department, etc.) within their own jurisdiction and with larger government entities that they interact with.
- Coordinate an initial stakeholders meeting where the vision and goals of the project are expressed and the background of GIS technology is described, if needed.
- Coordinate with other municipal agencies for data sharing provisions.
- Determine a mechanism of communication to keep the stakeholders aware of the progress of the project.
- Develop a basic understanding of the available precedents in their region/state and research the available technologies that can be applied to their project.

Upon project completion, comprehensive plan development functionality will require very little administrative support. Administrative tasks may include loading or upgrading new versions of the software or patches, providing for constant data flow, and maintaining yearly support contracts on the hardware and software. However, once the system becomes distributed across several departments or over the web, there are various other management requirements that need to be fulfilled on a weekly or monthly basis.

At the point where the system grows beyond single desktop users, a devoted administrator or system manager needs to be established. This is essential for the following reasons:

- The system will now be interfacing with other technology systems already in place. Therefore, someone needs to maintain contact with the technology personnel that maintain these systems.
- The manager needs to put into place quarterly training schedules to maintain user knowledge of the system.
- Funding will undoubtedly be required to either maintain the system long-term, or continue to expand the system, which requires funding research and applications for grants.

9. Costs:

Hardware	**Typical Unit Cost**
Minimum Workstation	$2,000
Optimum Workstation	$3,200
Laptop	$2,400
Web/FTP Server	$8,500
Database Server	$12,000
Data Warehouse Server	$18,000
Backup Server	$5,800
Printer (8x11 color)	$700
Printer (8x11 b/w production)	$2,000
Plotter	$12,000
Tape Library	$5,000

UPS	$700
Scanner	$1,500
Handheld	$300-$700
Off-the-shelf GIS desktop software	$700-$1,200

Software (all prices included license)	**Typical Unit Cost**
Standard GIS desktop software	$700-$10,000
Customized desktop vendor solution	$5,000-$15,000
Web-based vendor application	$15,000-$25,000
Customized web-based vendor solution	$20,000-$60,000

Miscellaneous	**Typical Unit Cost**
Training – (per person)	$700-$1,000
Training – general GIS	$700-$1,200
Licensing – desktop	$100-$500
Licensing – webapp (1st CPU)	$7,500-$12,000
Maintenance (per year)	$8,000-$15,000

10. Standards / Guidelines Summary

- Consider creating, customizing, or purchasing an application that integrates comprehensive plan development with other planning functions, such as plan review and development. This is most likely a more cost-effective solution.
- A GIS-based comprehensive plan development application should be built so that non-technical personnel can be trained to use the system.
- A Web GIS application should be simplified for the average citizen to use to view interactive maps from the comprehensive plan.
- Acquire input from all departments who will be involved in funding and/or utilizing the application before proceeding with the application design.
- Develop a detailed Quality Assurance/Quality Control (QA/QC) procedure for reviewing the accuracy of the GIS data and its attributes.
- Maintain data in the VBMP standard coordinate system (Virginia State Plane, NAD 83, Survey Feet).
- Create metadata (standard information about GIS data) for each data layer. Metadata tracks the date, origin, coordinate system, and other such information for data layers.

11. Startup Procedures/Steps

There should be a minimum of eight steps involved with developing a GIS-based comprehensive plan development application, after funding is in place to support the project. The steps can be performed in-house or by a consulting team.

The first task is to complete a detailed Needs Assessment. This process gathers information regarding existing operational procedures, hardware and software, GIS data, and personnel needs. It should include interviews of key individuals throughout the local government agency and other related government departments to obtain a comprehensive view of the agency's operations, and where GIS might improve them. Basic GIS concepts should be discussed and illustrated to those

interviewees that have little prior understanding of GIS. A comprehensive Needs Assessment should then be compiled from the results of the interviews. This document explains the various requirements for a GIS-based comprehensive plan development application in the following areas: personnel needs, spatial data development needs, applicable spatial analysis techniques, basic system requirements, including preliminary, general hardware and software recommendations, and training needs.

The second task is to develop a functional requirements document for the proposed system. This document should describe, as completely as possible, all of the technology and functionality that is to be included in the system. This document is used by the local government agency, or its consultant, as the blueprint for the GIS application. It should include the following topics:

- Hardware specifications
- Software purchases
- Detailed descriptions of work-flow, and examples of the graphic user interfaces
- Describe each tool that is part of that graphic user interface, and its functionality
- Describe how data would flow between the different databases and data warehouses, if applicable
- Describe the redundant security measures that will be put in place to make certain of data integrity and confidentiality, when applicable
- Analytical techniques that the application/system provides
- Describe each of the potential products (reports, maps, charts, summary tables) that the user will be able to generate within the system

The third task should be to compile or develop spatial data that can be used by the evolving application. Data can be gathered from a number of online sources, as well as county/city departments. The data layers gathered and maintained should match at least the minimum list provided in Section 1 of this document and can be acquired through the methods described in Section 3 of this document.

On completion and acceptance of the functional requirements document and the development of the spatial and attribute data, the system development and test phase can begin. During this time, the application will be customized as it was outlined in the functional requirements phase. The local government agency should require periodic reviews of the application at particular milestones, such as 50% and 75% completion. This will make certain that problems with the application will be recognized early in the development process, and that the local government agency remains a part of the development process throughout the project timeline.

When the application is nearing 100% completion, it should be installed and tested in the environment in which it will ultimately be used. This allows the users to test the system alongside the application developers, and determine any system integration problems that might arise. It also gives the developers the opportunity to test the application's functionality in a real-world situation. This testing process should be as comprehensive as possible. Each process detailed within the functional requirements should be tested and evaluated at this point.

User training commences once the application reaches completion and is fully documented. Different levels of tutorials and system documentation should be developed depending on the hierarchy of users. Time should be spent at this stage of the project with each potential user of the system to make certain that the proper education occurs. Training should be done through

lessons that use real-life examples of system application. This strategy greatly enhances users' ability to apply the functionality to their jobs.

The next phase of the project should include a document that describes a future plan for wider system development. This document accomplishes two goals. The future plan gives the local government agency ideas on how the system might grow to assist other facets of its business practices. Secondly, it provides the agency with a ready-made grant proposal for applying for potential funding sources.

The final phase of a successful implementation of a GIS-based comprehensive plan development application is ongoing technical support. The local government agency should always include this contingency within its cost estimates of a project for a minimum of three months after a system has been put into place. No matter how effective an application appears, problems and system changes inevitably impact the functionality of an application.

12. Estimated time line and/or implementation (stand alone) schedule:

Phase	**Duration**
RFP/Contract process (construction, posting, proposal acceptance, review, award of contract)	4-6 months
Needs Assessment	1 month
Functional Requirements	1-2 months
Data Development	4-6 months
System Development and Testing	4-6 months
Installation and Testing	1 month
User Training	½ month
Plan for Future Development	¼ month
Ongoing Support	3 months

13. Best Practice Examples in Virginia

Loudoun County
Department of Planning
1 Harrison Street SE
3rd Floor
Leesburg, VA 20175
703-777-0441
http://www.loudoun.gov/planning/index.htm